Job Loss Analysis

Control No: 2000295 **Status:** Closed **Original Date:** 31/May/2012

Last Date Closed:

Organization: Global Manufacturing

JLA Type: Global Mfg -Shared

Work Type: Technical Process Engineering

Work Activity: Air-Cooler Monitoring with Infrared Imaging

Personal Protective Equipment (PPE)

☐ Goggles	☐ Hearing Protection	☐ Warning Device	☐ Gloves(Nitrile, rubber, leather)
☐ Face Shields	☐ Hard Hat	☐ Tagout/Lockout kit	☐ Other
☐ Safety Glasses	☐ Safety Shoes	☐ Hi Viz Jacket	☐ Other
☐ Safety Back Belt	☐ Safety Cones	☐ Welding Hood	☐ Other

Reviewers

Reviewer Name	Position	Date Approved
Steve Leichty	Senior Staff Engineer, Global Mfg.	5/31/12
Les Jackowski	ETC	5/31/12
Chris Bennett	ETC	5/31/12

Development Team

Development Team Member Name	Primary Contact	Position
Tin Yin Lam	310-615-5715	Global Mfg Heat Exchanger Specialist

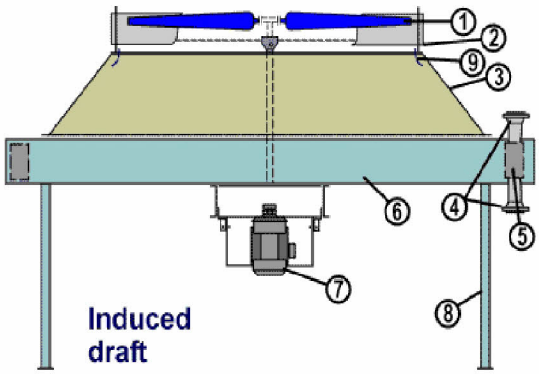
Job Steps

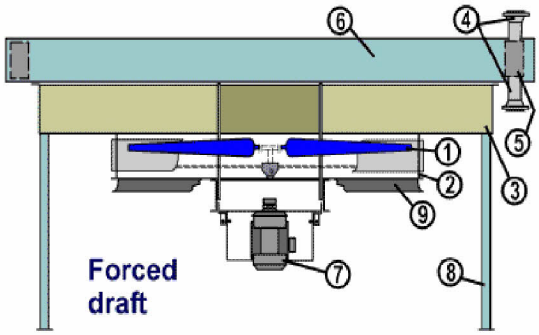
No.	Job Steps	Potential Hazard	Critical Actions
1.	Understand the objective: 1. Relate IR imaging information with field performance – high pressure drop across the air-cooler or insufficient cooling capacity. 2. Compliment the information obtained by other monitoring techniques such as HexMonHTRI and visual inspection. 3. More informed decision to implement corrective or improvement measures.	1. Making corrective or improvement decisions based on incomplete or missing information.	1. Review this document 2. Consult with BIN leader and heat exchanger specialist.
2.	Understand the technology: 1. Infrared imaging measures the surface temperature of an object. In this case, the tube OD temperature of the air-cooler. 2. Tubes that are plugged or with low flow typically have lower surface temperature.	1. Do not have sufficient knowledge to interpret the infrared images.	1. Review this document 2. Consult with BIN leader, heat exchanger specialist, and local IR specialist to understand the technology.
3.	Be familiar with the air-cooler to be inspected. 1. Is this an induced-draft or forced-draft air-cooler? 2. How many bundles per bay? Are all the bundles in the same service? 3. Is this a one-pass or multi-pass air-cooler. 4. For air-coolers with multiple bays, be familiar with how the inlet/outlet headers are routed. *Note: if you are not familiar with the air-cooler terminologies, please refer to the brief description in Appendix I.* 5. Be familiar with the history of the equipment including whether there are any plugged tubes from past leakage and their locations. Plugged tubes are cold and could be misinterpreted as plugged by the process fluid. Review history briefs in RIMS.	1. Do not have sufficient information to interpret observations.	1. Review PFD of the process unit. 2. Review P&ID around the air-coolers 3. Field walk the system. Take pictures of the air-cooler and the inlet/outlet headers. 4. Discuss with BIN leader and heat exchanger specialist.
4.	Be familiar with the process fluid in the air-cooler 1. Typical velocity and inlet/outlet temperature ranges to be expected	1. Do not have sufficient information to interpret observations.	1. Be familiar with the process unit. 2. Consult with BIN leader.

No.	Job Steps	Potential Hazard	Critical Actions
	2. Properties of the process fluid in the air-cooler. a) Would the fluid solidify when overcooled (example: waxy hydrocarbons, resid)? b) Fluid with particulates which settles in the tube? c) Salt precipitation (hydroprocessing units)		
5.	Meet with infrared camera technologist to go over expectations: 1. Take image of the bundle along the long axis of the tubes. See example images in the appendix. 2. For induced draft air-coolers, one can take the image of the <u>bottom</u> side of the air-cooler only. 3. *Note: exhaust air from air-coolers can be <u>very</u> hot, >200°F in some installations. Please perform LPSA and necessary precautions to avoid injury.* 4. For forced-draft air-coolers, take the image of the <u>top</u> side of the air-cooler. 5. For forced-draft air-coolers, taking the image of the <u>bottom</u> side if the fans are off. 6. Take the image of the header boxes and/or inlet/outlet headers as for reference temperature. 7. For services with water injection, take images around each injection point to ensure the injection is working. Water injection should show up as a temperature disruption in the IR imaging.	1. Do not have sufficient information to interpret observations.	1. Hold discussion session with infrared camera technologist.
6.	Image interpretation 1. If all the hydraulic and heat transfer conditions of all the tubes are similar, the IR imaging should show a uniform temperature. See IR image of Richmond SDA Unit E-130 A-Bay in Appendix II. 2. If the temperature profile of the tubes in the same bundle or the same bay is very different – some tubes are either much hotter or colder than others, indicate mal-distribution of	1. Failure to interpret the image properly.	1. Consult with local IR specialists to understand the location of the images. 2. Consult with BIN leader and heat exchanger specialist to interpret process implications.

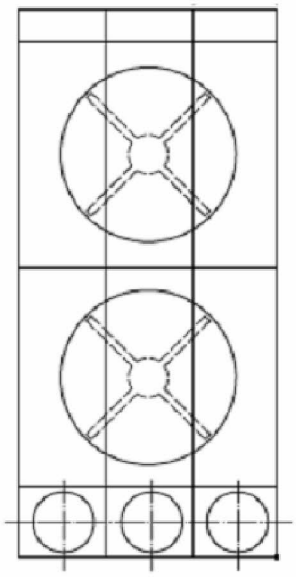
No.	Job Steps	Potential Hazard	Critical Actions
	process fluid most likely due to plugging. See example IR images in Appendix II. 3. For services with multiple bays, difference in hydraulic and heat transfer performances may reflect poor design of distribution headers. Note the difference in E-130 A-Bay and C-Bay in Appendix II. 4. Consult with a heat exchanger specialist from Global Mfg. or ETC if help is needed to interpret the data.		

Appendix I: Air-Cooler Terminologies

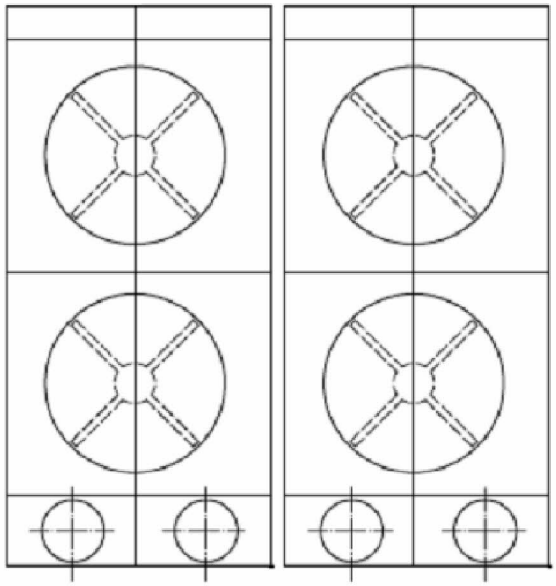




1. Fan
2. Fan ring
3. Plenum
4. Nozzle
5. Header
6. Tube bundle
7. Drive assembly
8. Column support
9. Inlet bell

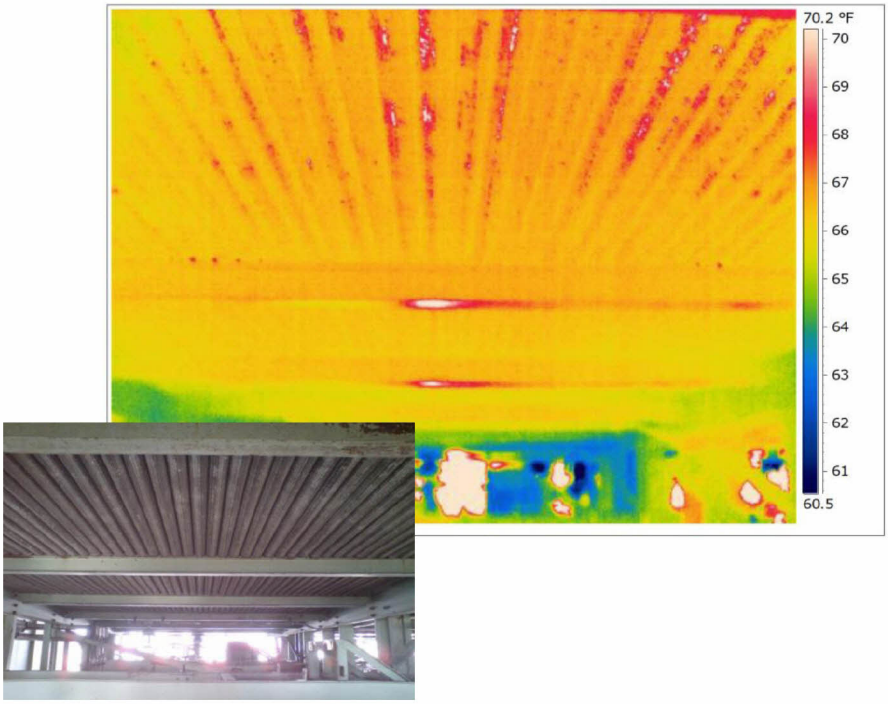


One Bay
With
Three Bundles

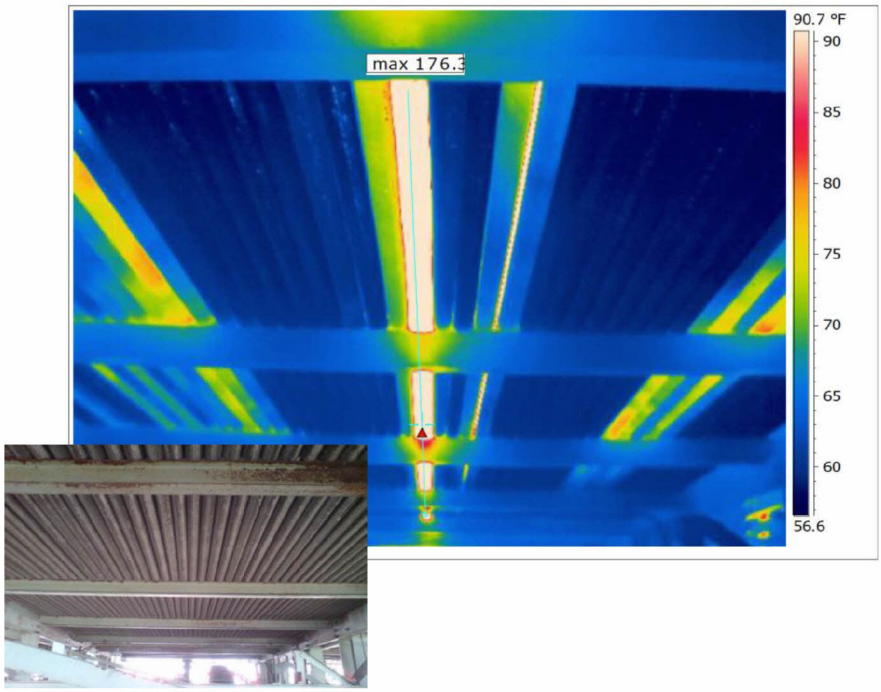


Two Bays
With
Two Bundles Per Bay

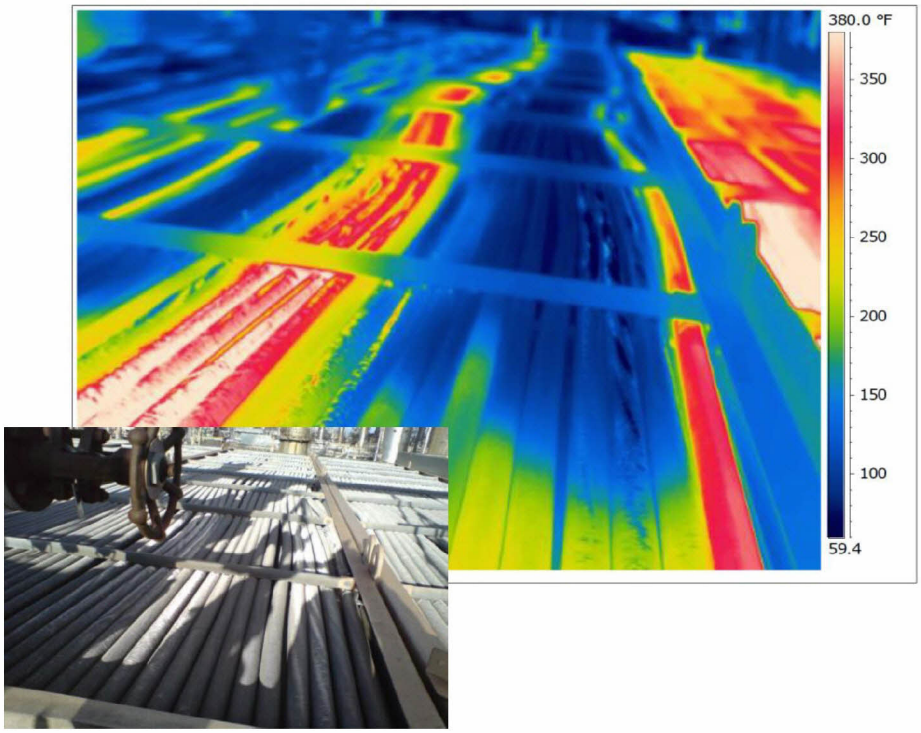
Appendix II: Example Infrared Images of Air-Coolers



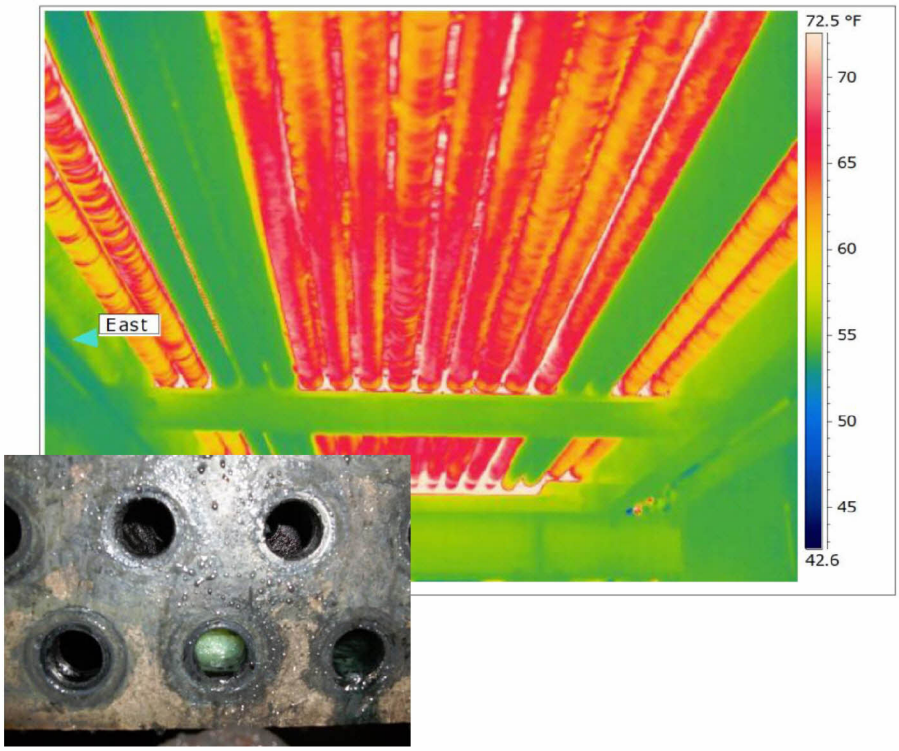
Richmond SDA Unit E-130 A-Bay. The temperature of the tubes is uniform which indicates uniform heat transfer and flow conditions in the tubes.



Richmond SDA Unit C-Bay. Note the very hot tube near the center which probably has a very high flow rate. There are a few "warm" tubes on either side. The very cold tubes (dark blue) are mostly likely plugged.



Richmond SDA Unit E-150 C-Bay. A few tubs with very high surface temperature. The cold tubes are either completely or partially obstructed. Also note the twisting of the hot tubes due to thermal expansion.



Richmond RLOP E-1980 A-Bay. The air-cooler has a history of being plugged by wax. The cold tubes are either completely or partially plugged. The inset picture shows wax found in the tubes in subsequent cleaning.